Stormwater Management Pond Sediment Valuable Resource or Costly Waste?

2024 SMWG Sponsor Forum

Francine Kelly-Hooper, Ph.D.

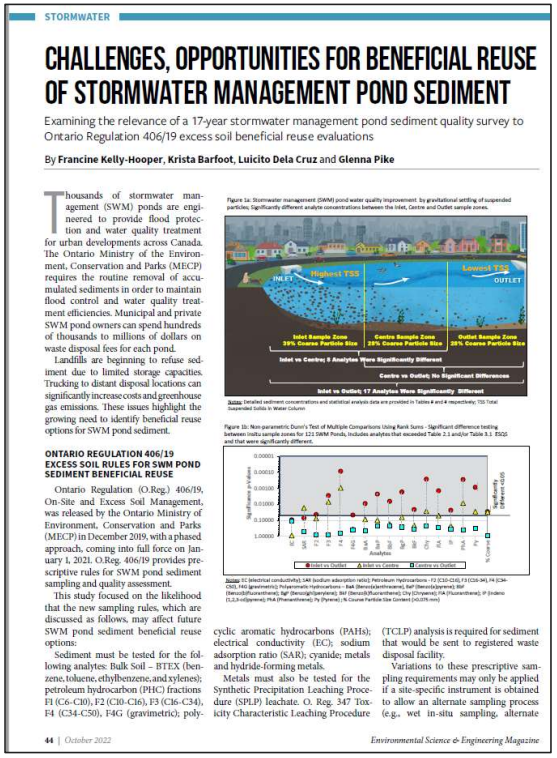
Canadian Sediment Lead & Hydrocarbon Forensics Scientist

19-year Canadian SWM Pond Sediment Chemistry Study Results

- #1 contaminant sources → Asphalt and coal tar sealants
- Leachate and toxicity testing supported safe beneficial reuse
- Successful beneficial reuse case studies

2005-2024 Chemistry Survey of 371 Sediment Samples Collected from 121 Residential SWM Ponds

October 2022 Environmental Science and Engineering Article



STORMWATER

CHALLENGES, OPPORTUNITIES FOR BENEFICIAL REUSE OF STORMWATER MANAGEMENT POND SEDIMENT

Examining the relevance of a 17-year stormwater management pond sediment quality survey to Ontario Regulation 406/19 excess soil beneficial reuse evaluations

By **Francine Kelly-Hooper, Krista Barfoot, Luicito Dela Cruz** and **Glenna Pike**

Thousands of stormwater management (SWM) ponds are engineered to provide flood protection and water quality treatment for urban developments across Canada. The Ontario Ministry of the Environment, Conservation and Parks (MECP) requires the routine removal of accumulated sediments in order to maintain flood control and water quality treatment efficiencies. Municipal and private SWM pond owners can spend hundreds of thousands to millions of dollars on waste disposal fees for each pond.

Landfills are beginning to refuse sediment due to limited storage capacities. Trucking to distant disposal locations can significantly increase costs and greenhouse gas emissions. These issues highlight the growing need to identify beneficial reuse options for SWM pond sediment.

Figure 1a: Stormwater management (SWM) pond water quality improvement by gravitational settling of suspended particles; Significantly different analyte concentrations between the Inlet, Centre and Outlet sample zones.

Notes: Detailed sediment concentrations and statistical analysis data are provided in Tables 4 and 4 respectively; TSS Total Suspended Solids in Water Column

Figure 1b: Non-parametric Dunn's Test of Multiple Comparisons Using Rank Sums - Significant difference testing between inlet/a sample zones for 121 SWM Ponds, includes analytes that exceeded Table 2.1 and/or Table 3.1 ESQS and that were significantly different.

Notes: EC (electrical conductivity); SAR (sodium adsorption ratio); Petroleum Hydrocarbons - F2 (C10-C16), F3 (C16-34), F4 (C34-C50), F4G (gravimetric); Polyaromatic Hydrocarbons – BaA (Benzo[a]anthracene), BaP (Benzo[a]pyrene), BbF (Benzo[b]fluoranthene), BghiP (Benzo[ghi]perylene), BkF (Benzo[k]fluoranthene), Chy (Chrysene), FLA (Fluoranthene), IP (Indeno [1,2,3-cd]pyrene), PHA (Phenanthrene), Py (Pyrene); % Course Particle Size Content (>0.075 mm)

ONTARIO REGULATION 406/19 EXCESS SOIL RULES FOR SWM POND SEDIMENT BENEFICIAL REUSE

Ontario Regulation (O.Reg.) 406/19, On-Site and Excess Soil Management, was released by the Ontario Ministry of Environment, Conservation and Parks (MECP) in December 2019, with a phased approach, coming into full force on January 1, 2021. O.Reg. 406/19 provides prescriptive rules for SWM pond sediment sampling and quality assessment.

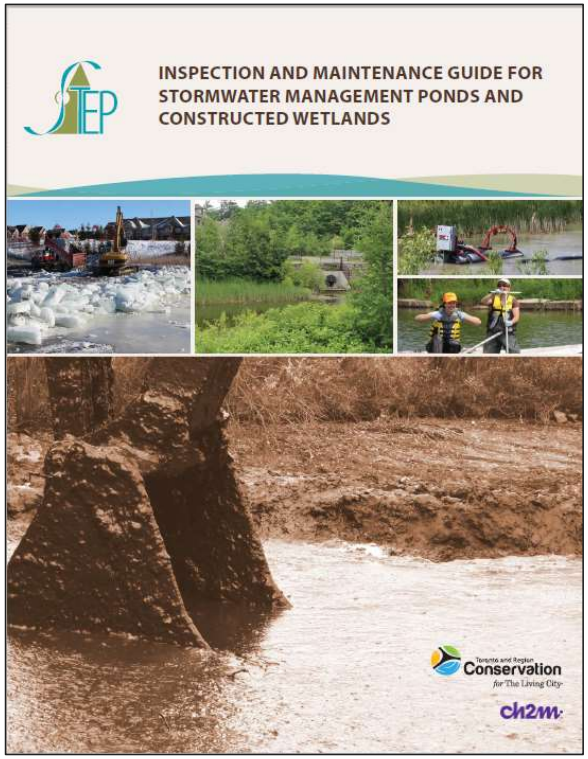
This study focused on the likelihood that the new sampling rules, which are discussed as follows, may affect future SWM pond sediment beneficial reuse options:

Sediment must be tested for the following analytes: Bulk Soil – BTEX (benzene, toluene, ethylbenzene, and xylenes); petroleum hydrocarbon (PHC) fractions F1 (C6-C10), F2 (C10-C16), F3 (C16-C34), F4 (C34-C50), F4G (gravimetric); polycyclic aromatic hydrocarbons (PAHs); electrical conductivity (EC); sodium adsorption ratio (SAR); cyanide; metals and hydride-forming metals.

Metals must also be tested for the Synthetic Precipitation Leaching Procedure (SPLP) leachate. O. Reg. 347 Toxicity Characteristic Leaching Procedure (TCLP) analysis is required for sediment that would be sent to registered waste disposal facility.

Variations to these prescriptive sampling requirements may only be applied if a site-specific instrument is obtained to allow an alternate sampling process (e.g., wet in-situ sampling, alternate

2018 Toronto and Region Conservation Authority Sediment Maintenance Manual



PhD Research & Ongoing Regulatory Collaborations

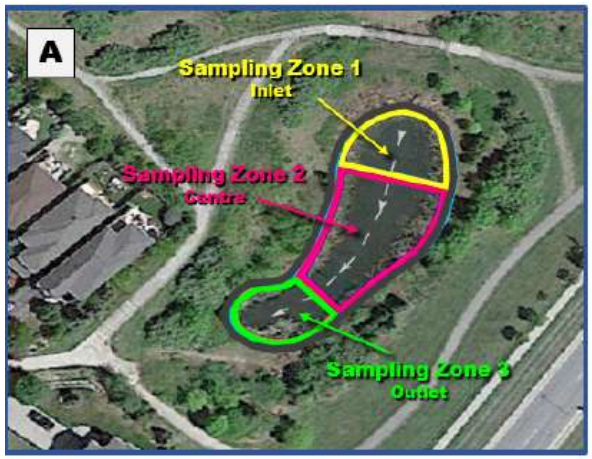
Sediment Sampling & Chemistry Analysis

Earthworm and Plant Toxicity Testing

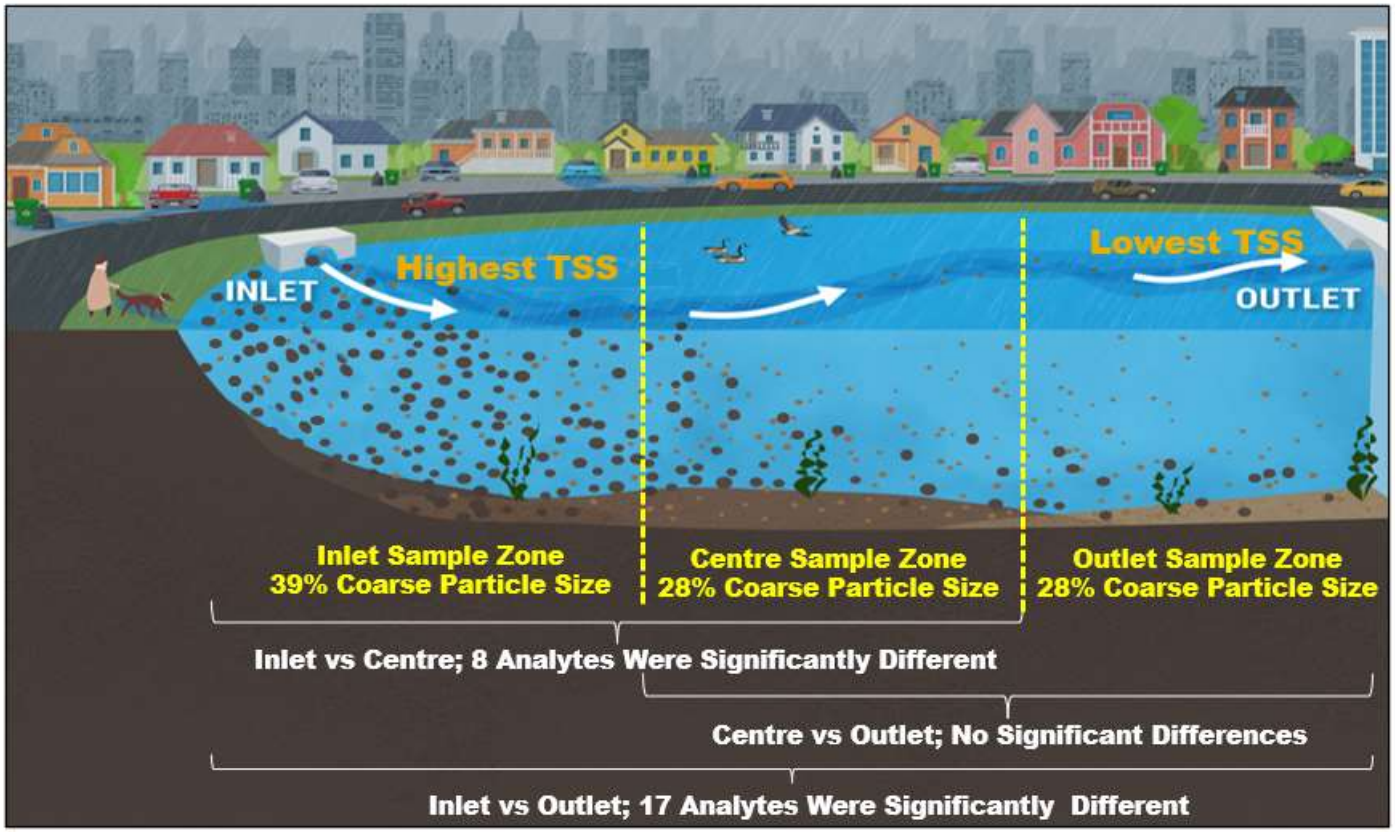
Field Trials

Insitu Sediment Sample Zones

- **Multiple discrete samples within each zone combined into 3 composite samples for ponds with 1 inlet.**
- **1 additional composite sample per additional inlet.**



Sediment Quality Significant Differences Between Sample Zones



Sediment Chemistry Analytes

#1 Contaminants

- Total Petroleum Hydrocarbons (TPH)
- Polycyclic Aromatic Hydrocarbons (PAH)

- Metals
- Road salt analytes – chloride, electrical conductivity, sodium adsorption ratio
- Nutrients
- Particle size

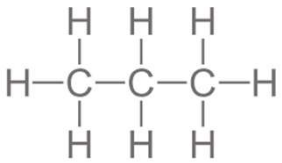
TPH & PAH Compounds

Hydrogen and carbon found in crude oil, coal and their refined & partially combusted products

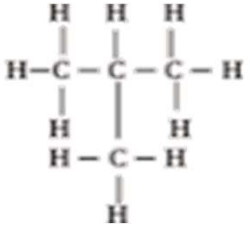
1) Aliphatic TPH Examples

Straight chains, branched trains non-aromatic rings

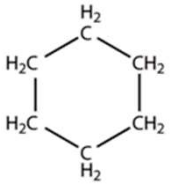
Propane

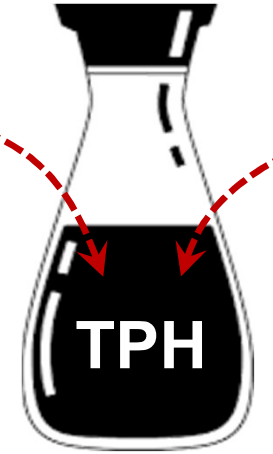


2-methyl-propane



Cyclohexane

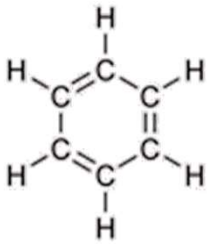




2) Aromatic PAH Examples

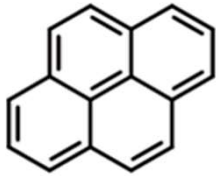
Single and Multiple Benzene Rings

Benzene (single ring)



Polyaromatic Hydrocarbons (PAH)

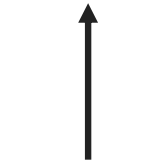
Multiple Benzene Rings



Pyrene

Urban SWM Pond Sediment TPH/PAH Source Examples

Liquids More Bioavailable



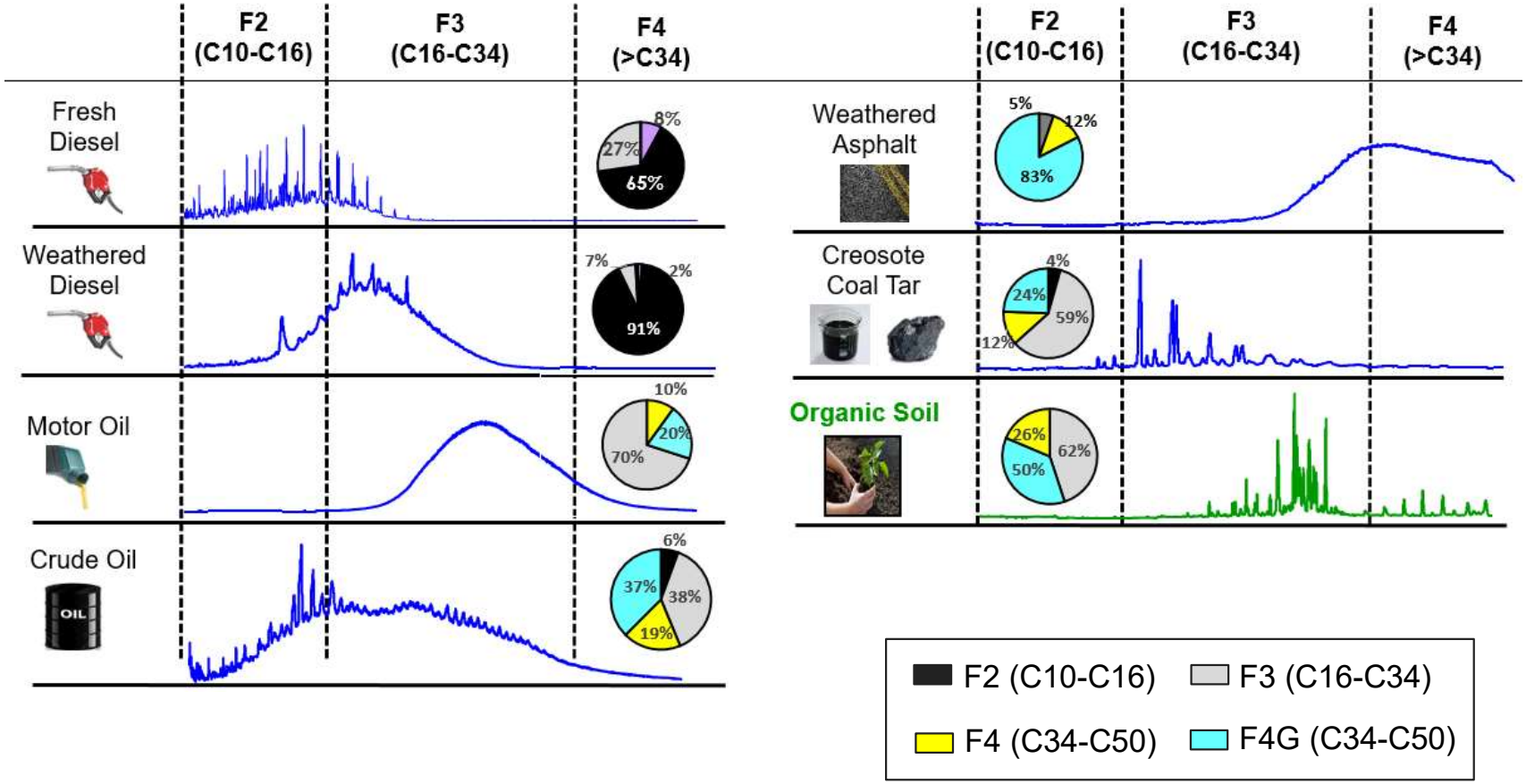
Solids Less Bioavailable

Examples: gasoline, diesel, engine oil, etc.

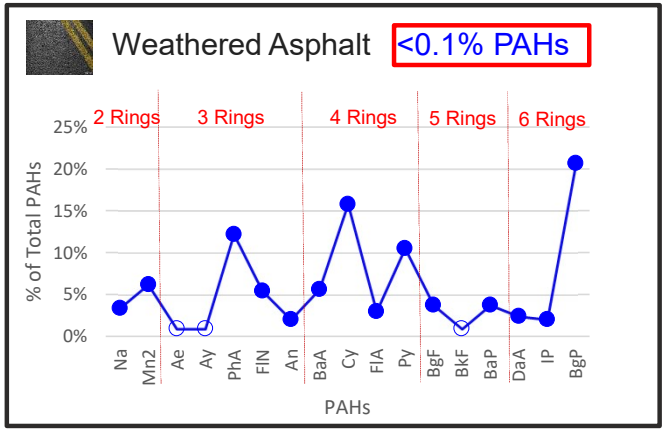
Examples: aged asphalt & coal tar sealant, tire rubber, etc.

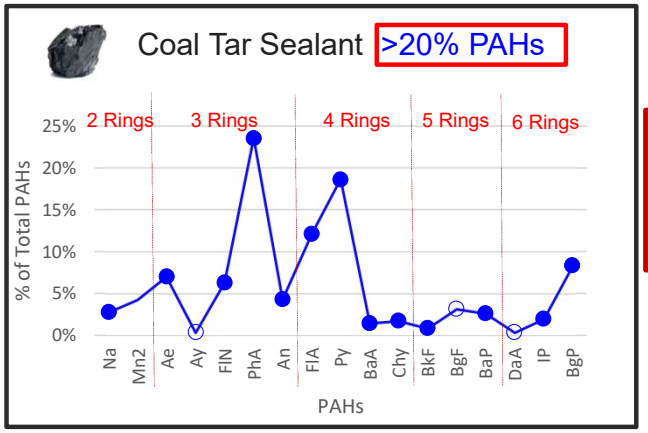
TPH/PAH Source Identification Tools

TPH Carbon Ranges & GC-FID Chromatogram Patterns

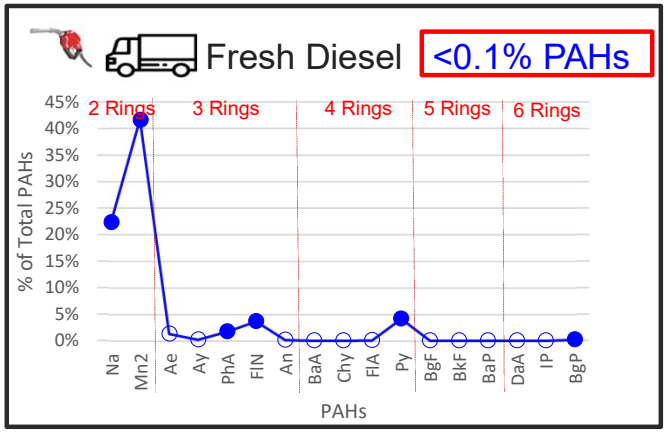


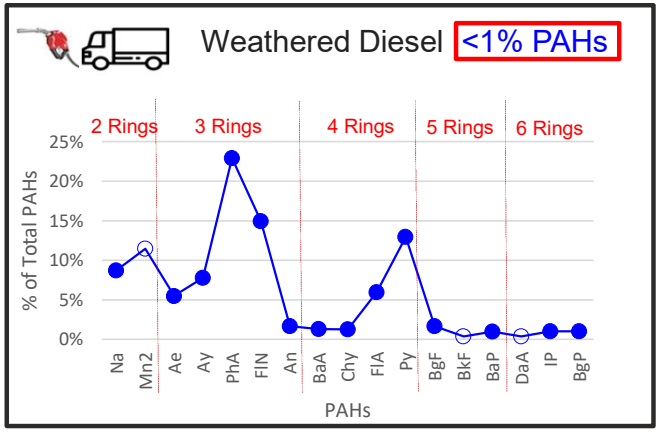
PAH Ring Sizes and % Content of TPH





Coal PAH content is 1000x higher than crude oil PAH content





United States CTS Bans and Restrictions

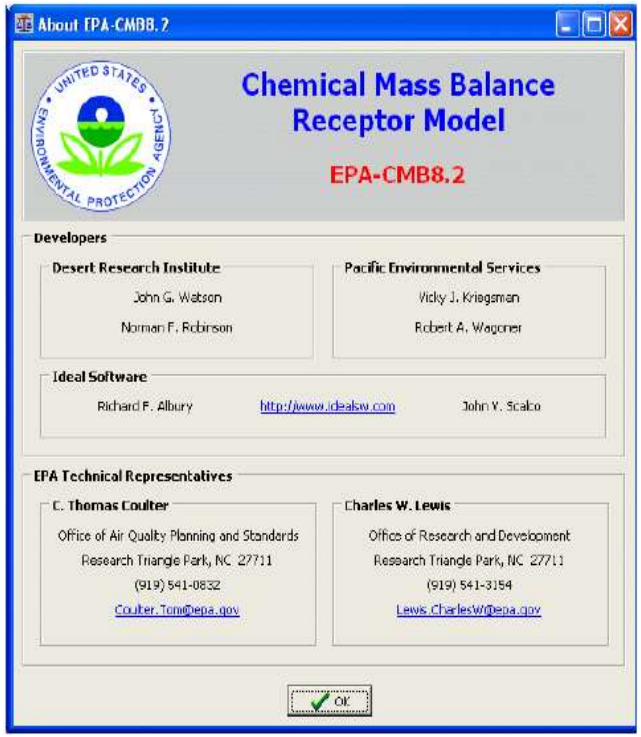
Government Restricted Use

Restricted Use, for Public & Private

Outright Ban

Home Depot and Lowes headquarters that no longer sell CTS throughout the US or Canada

In 2015 the Minnesota Pollution Control Agency Contacted the Ontario Ministry of Environment Regarding CTS Bans in Canada



- The Ontario MOE contracted Francine Kelly-Hooper to evaluate her SWM pond sediment chemistry database for PAH content from CTS sources
- The EPA CMB model identified CTS as the primary PAH source in most sediment samples.
- Asphalt was the primary TPH source in every sample.

Toxicity Testing and Tissue Analysis of TPH/PAH Contaminated Sediments

- Bulk soil test methods identified high TPH/PAH concentrations
- Toxicity Characterization Leaching Procedure (TCLP) identified non-detectable TPH/PAH concentrations, indicating they were not water soluble
- Earthworm and plant toxicity tests and tissue analysis observed no impacts.
- These results supported federal and provincial approvals of beneficial reuse field trials.

SWM Pond Sediment Beneficial Reuse Case Studies

Case Study #1: 2022 Sediment Reuse on Highway Right-of-Ways

Transportation Association of Canada Environmental Achievement Award

2019

2020

- Reused 3000 truckloads of sediment
- $3.3 million waste disposal savings

Case Study #2: 2016 Sediment Reuse as Tree Nursery Soil Amendment Material

Ontario Public Works Association Environmental Project of the Year

- Reused 60 truckloads of sediment
- $60,000 waste disposal savings

Case Study #3 – 2020 SWM Pond Sediment Beneficial Reuse as Boulevard Landscaping Soil

Canadian Association of Municipal Administrators Innovation Award

- 300 m^3 of Sediment Spread Across Four Boulevards
- $31,000 Landfill Tipping Fee Savings

Conclusions

- 99% of sediment samples failed background TPH regulatory limits due to asphalt sources.
- 65% of sediment samples failed background PAH regulatory limits due to coal tar sealant sources.
- Leachability and toxicity testing indicated low bioavailability and beneficial reuse risks.
- The Ontario Ministry of Environment has permitted safe beneficial reuse of SWM pond sediments within roadway environments (e.g. landscaping materials).

Questions?

francine.kelly-hooper@GHD.com
519-502-3122